

A. K. PANDEY\* & S. S. JHA\*: **Seed structure**  
**in *Aeschynomene* (Fabaceae)**

A. K. パンディ\*・S. S. ジャ\*: マメ科クサネム属の種子構造

Genus *Aeschynomene* of tribe Aeschynomeneae (Papilionoideae—Fabaceae) includes 150 species distributed in tropics to warm temperate regions of America, Africa and Asia (Rudd 1981). In India, pith of *A. aspera* and *A. indica* are used for making sunhats, floats, etc. and charcoal of latter in fire works and gun powder. A perusal of literature reveals that development and structure of seeds in *Aeschynomene* have not been studied and present communication, therefore, describes these aspects in three species of this genus.

**Material and methods** The species studied during present study are listed in Tab. 1 together with their voucher information. Flower buds and seeds at all stages of development were fixed in FAA. Preparations of microtome sections were made following standard paraffin techniques. Microtome sections cut between 8–15  $\mu$ m thickness were stained in safranin-fast green combination. For SEM observations, seeds were coated with a thin layer of gold (200Å) in sputter coating unit. Scanning was done on Jeol-JSM 35C SEM at National Botanical Research Institute, Lucknow. In all the seeds, the side below the hilum was scanned at a constant tilt (45°) with the accelerating potential at 15 kv.

**Observations** Developmental anatomy of seeds in *A. aspera* and morphology and anatomy of mature seeds of *A. indica* and *A. sensitiva* have been

Tab. 1. Studied taxa and collections.

<i>Aeschynomene aspera</i> L.	Bihar, Santhal Pargana Barhait, Pandey 1088
<i>Aeschynomene indica</i> L.	Bihar, Santhal Pargana Barhait, Pandey 1089
<i>Aeschynomene sensitiva</i> L.	Royal Botanic Gardens, Kew, England, Seed Herbarium Acc. No. 254-72. 02386

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studied.

**Ovule.** The ovary contains commonly 4 ovules attached to the marginal placenta. The ovule is campylotropous, crassinucellate and bitegmic (Fig. 1A, B, C). The outer integument is thicker than the inner one and it completely overgrows the latter. The micropyle is formed both by the outer and inner integuments in a zig-zag fashion (Fig. 1B, C). Nucellus is quite massive on the chalazal and lateral sides but represented by few number of cell-layers towards the micropylar side. The ovule is supplied with a single vascular strand that passes through the raphe and terminates at the chalaza (Fig. 1B).

**Seed development.** Normally, all the ovules in an ovary develop into mature seeds and during the process each part of the ovule is subjected to a series of changes.

**Endosperm.** The endosperm development is of Nuclear type. Cellularisation of endosperm commences from the micropylar side and gradually progresses towards the chalazal end. By the time cotyledons are well-differentiated in the embryo, the endosperm becomes completely cellular (Fig. 1F). During further development of seed, the endosperm tissue is utilised and by the time seed matures almost all the endosperm is consumed leaving behind 2 layers of cells that show considerable thickening on their walls (1H, I). In *A. indica* and *A. sensitiva*, the endosperm is represented by a single layer of cells (Fig. 2B, F). The cells of the endosperm are thick-walled and show dark reddish contents.

**Nucellus.** At the organised female gametophyte stage, the nucellus is quite massive (Fig. 1B, C) and its cells are compactly arranged and show dense cytoplasmic contents and prominent nuclei (Fig. 1D). After fertilisation, the degeneration of nucellar cells starts from the micropylar side and proceeds towards the chalazal end. The cells of the nucellus below the embryosac, however, persist till the cotyledons are well differentiated in the embryo (Fig. 1F) and are last to be consumed leaving no trace of this tissue in the mature seed (Fig. 1H, I).

**Inner integument.** At the organised female gametophyte stage the inner integument is 2 cell-layers at the level of the embryo sac (Fig. 1D) but at the micropylar end the number is greater. The cells of both the layers of inner integument are nearly uniform in structure. After fertilisation tangential stretching of cells of both the layers of the inner integument begins and by the

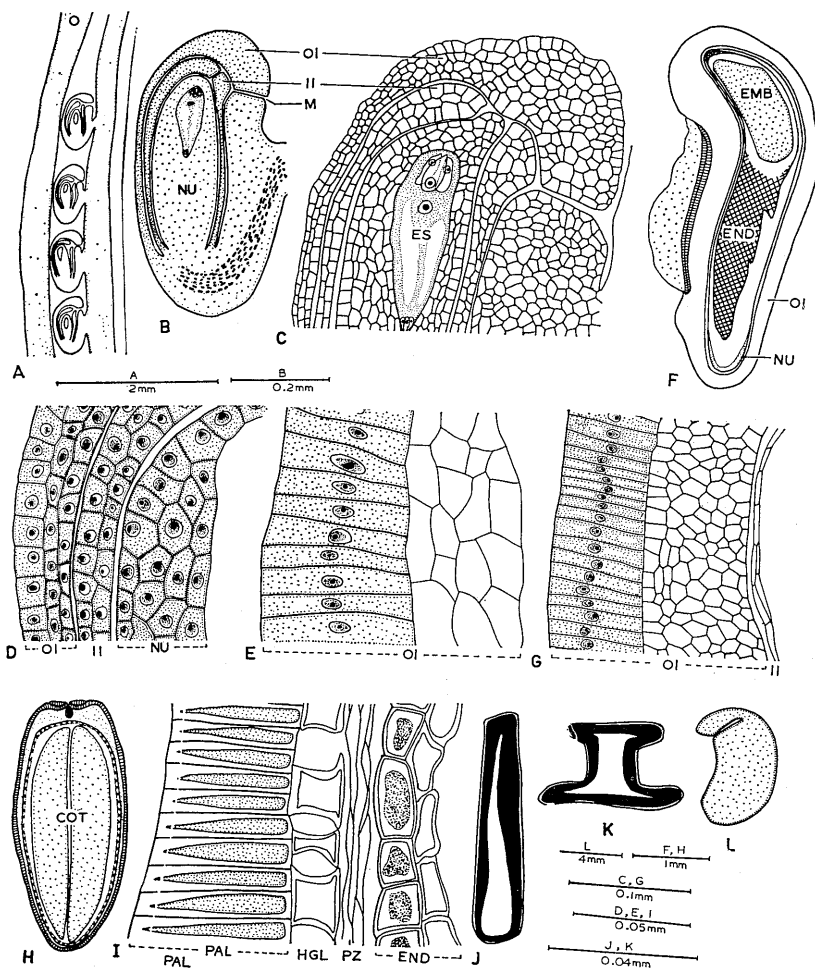


Fig. 1. *Aeschynomene aspera*. A. Longitudinal section of ovary showing attachment of ovules on marginal placenta. B. Longitudinal section of ovule at organised female gametophyte stage. C, D. Longitudinal sections of part of ovule at organised female gametophyte stage. E. longitudinal section of part of developing seed at globular embryo stage. Note radial elongation of epidermal cells. F. Longitudinal section of developing seed at well-differentiated cotyledonary stage. Note cellular endosperm. G. Longitudinal section of part of developing seed at same stage. H. Cross section of mature seed. I. Cross section of part of mature seed. J, K. Macrosclereid and osteosclereid in surface view. L. Mature embryo. (COT: cotyledons, EMB: embryo, END: endosperm, ES: embryo sac, HGL: hourglass cells, II: inner integument, M: micropyle, NU: nucellus, O: ovary, OI: outer integument, PAL: palisade-like cells, PZ: parenchymatous zone.)

time cotyledons are well-differentiated in the embryo the cells are fully stretched (Fig. 1G). The degeneration of the inner integument commences from the central region of the antiraphe and raphe sides and gradually progress towards chalazal and micropylar ends. As the seed attains maturity no trace of the inner integument is seen (Fig. 1I).

**Outer integument.** At the organised female gametophyte stage the outer integument is 3 cell-layers at the level of the embryo sac (Fig. 1C, D). The number of cell-layers of the outer integument reaches upto 8 towards micropylar side of the ovule. After fertilization, cells of all the layers of the outer integument except those of the outer epidermis undergo active periclinal and anticlinal divisions resulting in 4-5 layered outer integument on raphe and antiraphe sides by the time late-globular embryo stage is reached (Fig. 1E) however, cells at the micropylar end are more active in division and the resulting number of cell-layers of the outer integument in this region is greater. Further during the course of development of seed, the sub-epidermal cells continue to divide resulting in 10-layered outer integument by the time cotyledons are well-differentiated in the embryo (Fig. 1G). After this stage, degeneration of the sub-epidermal cells sets in from the inner side and gradually progresses towards the outer side. Consequently, only 4 to 5 layers of cells are left on the outer side in the mature seed (Fig. 1I). Following fertilisation, the outer epidermal cells begin to elongate radially and by the time late globular proembryo stage is reached, the cells are considerably elongated (Fig. 1E). The process of radial elongation continues till the cotyledons are well-differentiated in the embryo. At the late globular embryo stage itself, some of the cells of the outer epidermis lying towards the micropylar side, apart from showing radial elongation, show thickening of their walls. These cells take red stain with safranin. By the time cotyledons are well-differentiated in the embryo, the cells of the outer integument lying just below the outer epidermis show radial elongation, though only to a limited extent and they are arranged in a definite fashion (Fig. 1G). During further development of seed, the cells of the outermost layer differentiate as macrosclereids (Fig. 1I, J), and the cells lying just below the outer epidermis differentiate into hourglass cells or osteosclereids (Fig. 1I, K).

**Mature seed coat.** As mature seed coat of *A. aspera*, *A. indica* and *A. sensitiva* show a similar basic pattern of seed coat differentiation, a common description is provided unless otherwise specified. The outer integument alone

forms the seed coat. Major part of the seed coat consists of 4 to 5 layers of cells including the two outermost characteristic layers. The outermost epidermal layer is composed of radially elongated, palisade-like, highly lignified macrosclereids (Figs. 11, J, 2B, E). In *A. aspera* and *A. indica* the macrosclereids are differentially lignified so as to have a broader lumen towards their inner sides (Figs. 1I, 2B). In *A. sensitiva*, however, the macrosclereids are uniformly lignified (Fig. 2E, I). A distinct light line runs peripherally to the layer of

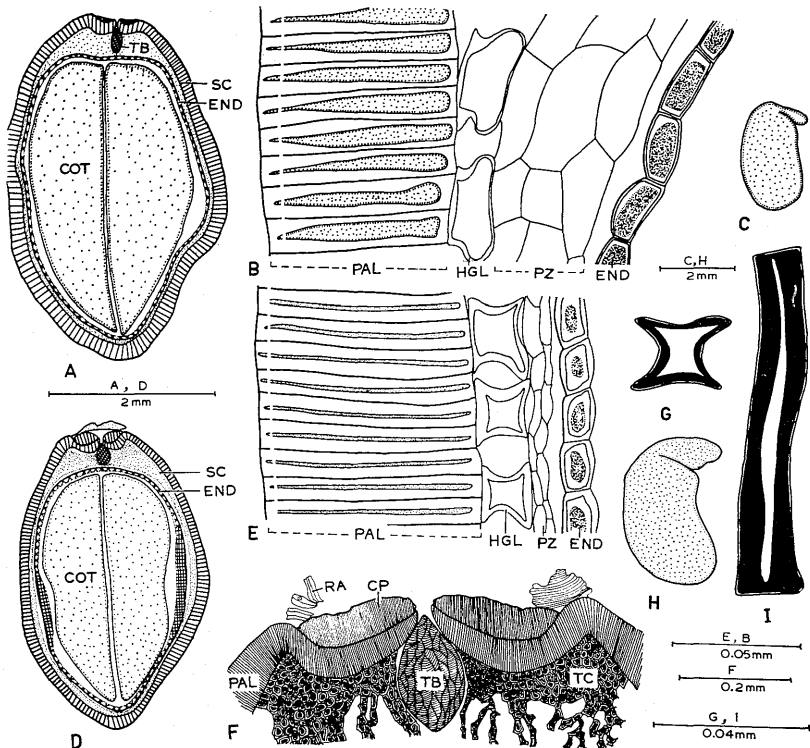


Fig. 2. *Aeschynomene* species. A. Cross section of mature seed of *A. indica*. Note tracheid-bar in hilar region. B. Cross section of part of mature seed of *A. indica*. C. Mature embryo of *A. indica*. D, E. Cross section of mature seed and part of mature seed of *A. sensitiva*. Note palisade, counter, palisade, tracheid-bar and tanniferous cells. G. Osteosclereid of *A. sensitiva* in surface view. H. Mature embryo of *A. sensitiva*. I. Macrosclereid of *A. sensitiva* in surface view. (COT: cotyledons, CP: counter palisade, END: endosperm, HGL: hourglass cells, PAL: palisade-like cells, PZ: parenchymatous zone, RA: rim aril, SC: seed coat, TB: tracheid bar, TC: tannin filled cells.)

macrosclereids. The macrosclereids near the hilar region are relatively longer. The layer of macrosclereids is underlain by a layer of osteosclereids. The osteosclereids are represented by biconcave and thick-walled cells whose shape varies. The osteosclereids have a relatively broader lower end with rounded corners in *A. indica* (Fig. 2B) whereas they are hourglass-shaped in *A. aspera* and *A. sensitiva* (Figs. 1K, 2E, G). The osteosclereids are uniformly thickened in *A. aspera* and *A. sensitiva* but in *A. indica* thickening is more on radial walls than tangential ones. The osteosclereids are of the shape of an hour-glass and more or less uniformly thickened (Fig. 1K). The osteosclereids in the sub-hilar region are relatively longer. The average size of macrosclereids and osteosclereids are recorded in Table-3. The remaining part of the seed coat consists of 2 to 3 layers of tangentially stretched parenchymatous cells (Figs. 1I, 2B, E).

Hilum. During early stages of embryogeny, the hilar region consists of thin-walled parenchymatous cells. After the globular stage of the embryo, two cell-layers of the hilum start differentiating into radially-elongated, palisade-like cells. The inner palisade layer lies in continuation with the palisade layer (layer of macrosclereids) of the seed coat. The outer known as the counterpalisade is restricted to the hilar region only (Fig. 1H). In a cross section, a pear-shaped tracheid-bar is discernible just below the hilar groove (Fig. 2A, D, F) and the remaining subhilar cells are stellate or rounded with abundant tanniferous substances (Fig. 2F). In *A. sensitiva* remains of funicle are present in the hilar region and constitute the rim aril (Fig. 2D, E).

Tab. 2. Seed morphology in *Aeschynomene*.

Species	Seed shape	Seed colour	Seed surface	Hilum shape	Hilum colour	Seed size ( $1 \times b$ ) (in mm)
<i>A. aspera</i>	Rniform with a beak	Chocolate brown	Smooth, glabrous dull	Circular	Dull black	2.25 $\times$ 1.75
<i>A. indica</i>	Oblong with a beak	Dark brown	Smooth, glabrous dull	Circular	Dull black	2.25 $\times$ 1.25
<i>A. sensitiva</i>	Compressed oval	Brownish Green	Smooth, glabrous shiny	Elliptical	black	3.0 $\times$ 2.25

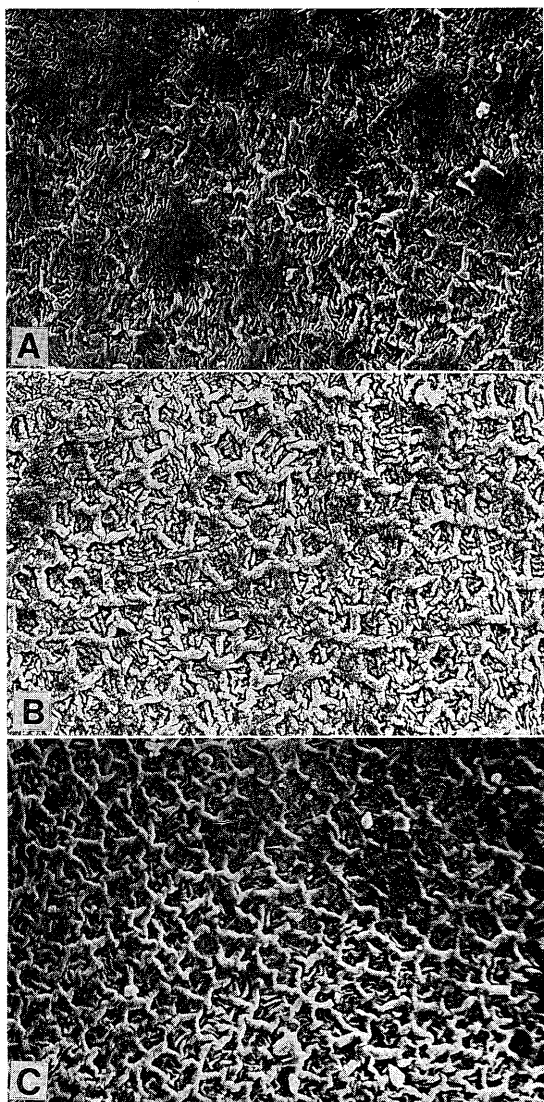


Fig. 3. *Aeschynomene* species (SEM photographs). A, B, C. Spermoderm of *A. aspera*, *A. indica* and *A. sensitiva*, respectively.  $\times 1500$ .

Embryo. The mature embryo occupies almost the entire length of the seed (Figs. 1H, 2A, D) and hypocotyl-root-axis is much shorter than the cotyledons (Figs. 1L, 2C, H).

Mature seed. Seed morphological data is given in Tab. 2. The spermoderm in all the three species is rugulate having raised ridges with irregular sides showing a tendency towards forming a reticulate pattern (Fig. 3A, B, C). The rugae are of two types: (i) small and thin rugae which lie at the surface, and (ii) robust and large rugae which are raised and appear to form a reticulum. In *A. aspera* and *A. indica*, the raised rugae are not so closely packed as seen in *A. sensitiva*. Lersten (1981) reported lophate spermoderm in *A. indica*.

**Discussion** The mature seed coat in *Aeschynomene* is formed by the outer integument alone. The mature seed coat is differentiated into a layer each of macrosclereids and oste-

Tab. 3. Average length and breadth of macrosclereid and osteosclereid in *Aeschynomene* (measurement in microns).

Species	Macrosclereid		Length	Osteosclereid Breadth		
	Length	Breadth		Middle	Upper	Lower
<i>A. aspera</i>	72.20	12	40.25	14.00	24.10	24.10
<i>A. indica</i>	68.14	12	32.12	13.95	24.00	22.50
<i>A. sensitiva</i>	83.95	12	12.5	14.05	18.05	14.32

osclereids followed by 2-3 layers of parenchymatous clls. The macrosclereids are differentially lignified in *A. aspera* and *A. indica* (present study), a feature also observed in majority of Papilionoideae (Jha 1987). On the other hand, in *A. sensitiva* lignification in macrosclereids is uniform. Uniform lignification of macrosclereids has also been observed in *Medicago arabica*, *M. lupulina*, *Oxytropis lapponica*, *Pongamia pinnata* and *Zornia gibbosa* (Pandey and Jha, unpublished). Kapuskar (1964) reported that two layers each of nucellus and inner integument persist in mature seeds of *Aeschynomene aspera*. During present study of this taxon, neither nucellus nor inner integument are seen in mature seeds as they degenerate during seed development.

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### References

- Jha, S.S. 1987. Development and structure of seeds in some Papilionoideae. Ph. D. Thesis, Bhagalpur Univ. Kapuskar, A.T. 1964. Studies in the embryology of the Leguminosae, Proc. Indian Acad. Sci. 60(8) : 87-94. Lersten, N.R. 1981. Testa topography in Leguminosae, subfamily Papilionoideae. Proc. Iowa Acad. Sci. 88(4) : 180-191. Rudd, V.E. 1981. Aeschynomeneae (Benth.) Hutch (1964). In R.M. Polhill & P.H. Raven (eds.), Advances in legume systematics, Kew, pp. 347-354.

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本研究では *Aeschynomene aspera*, *A. indica* および *A. sensitiva* の種子を研究した。その発生については *A. aspera* を用いた。これらのクサネム 属植物では種皮は外珠皮から作られており、Kapuskar (1964) が *A. aspera* で記録したような珠心または内珠皮の残存は観察されなかった。

□Centro de Pesquisas de Historia Natural (ed.): **Conheça o Verde** (サンパウロ博物研究会(編): 緑を知ろう) 291 pp., 41 figs. 1988. Prefeitura Municipal de San Paulo, Brazil. 表記研究会の会長 Y. Chida (千田良広) 氏の総括の下に、橋本梧郎氏を主とし、多くの日系ブラジル人、その他の人々の協力のもとにこの書は出版された。サンパウロ市には現在15の広大な公園があり、同市公園課との合意で、1985年に第1冊 Parque de Aclimação (気候馴化公園) が完成し、今年をもって第15冊までの出版が完了した。これらをまとめて合本としたのが本書である。各公園には自然林をふくむ地域が主体で、植栽の植物も多く、本書では木本植物をとり上げ、ときに重要と思われる多年生草本を収録した。各の分冊の表裏のカバーには 2~4 pp. の景観写真と植生の組合せ写真がカラーで印刷されている。各公園には公園の植生地区別をふくむ地図があり、これらにある樹木の学名、ブラジル名が科名の ABC 順に配列してある。このほかに Goro Hashimoto 氏の Introdução (サンパウロ市公園の植物) には全体の計画、1919年以来の研究略史がブラジル語と日本語で書かれている。また全巻の末尾には Listagem ge Ral das Plantas dos Parques が 22 pp. にわたって科名の ABC 順に種名その原典、異名、ブラジル名、原産地、関係する公園名の略称が配列してある。文献欄には Martius: Flora brasiliensis (Bailey, L. H. 版) (1947-76), Corner, E. J. H. et K. Watanabe (1969), Yuasa, H. et F. Maekawa (1987) のほかに橋本氏の著(1951, 1946) など内外多数の著作の表がある。綴こみの正誤表のほかに挿入の正誤表が2葉もあり、良心的に編集された様子がうかがえる。このような形の出版は世界でも例のないことではないか。市民に開かれた公園を目指す意図が全篇からにじみ出ている。本書が評者の目に特異なのは、ほとんど各頁の最下部 1/6 くらいの所が商業広告によって占められていることである。なお本書は日系人の同国への移住80周年祭記念を意識したものであり、同国でも自然環境破壊が問題意識としてとらえられていることが千田良広氏の文でわかる。日本語は 2 pp. 分しかない。これは日系の人々をふくむブラジル人のための書であるから当然である。なお橋本氏には先年出版されたブラジル植物記、および日本の青少年むけの氏の伝記が昨年出版されている。

(津山 尚)